

# ALTICE LABS WHITEPAPER

**NGM2**

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## Summary

All indicators point to an exponential growth of machine to machine communication. The use of the information of a series of sensors, associated to the use of a whole variety of actuators, allows the creation of a new world of applications that covers the various activity sectors. Operating gains, cost savings and the reinvention of processes are some of the key factors that will add to the adoption of this new paradigm. Telecommunications operators are paying attention to this market and have currently been multiplying initiatives and strategies to place themselves in a more comprehensive position in the value chain, with the aim of supporting new differentiating services that go beyond simply making connectivity available. This article aims at the presentation of the architecture of a horizontal platform for the creation and supply of M2M services, defined based on the aims of Apollo and IoT.est projects, which bridges the gap between the different services and the heterogeneity of networks and devices, and therefore stimulates the creation of new businesses.

# 1. Introduction

We are currently watching the massification of devices that are able to communicate, supporting the IoT — Internet of Things. There is a revolution underway supported by machines that are connected and that can interact without human intervention, providing different types of information and offering customised content and more experiences to an increasing number of more and more demanding customers.

Machine to machine communication (M2M) opens the door to a new world of innovative businesses, common to the various activity sectors, where the areas of telemetry, health, transportation, maintenance and remote control and, finally, security are emphasized. Communications operators need to speed the pace if they want to lead the transformation powered by this new market. They have to become the main stakeholders in the M2M ecosystem, facilitating the creation of new businesses, regardless of the sphere of action. In order for that to happen, communications operators need to develop their networks so that they support the fast creation of new services, based on distributed networks, which facilitates the transparent connection of heterogeneous devices, while assuring the compatibility with the normative directives.

This article suggests architecture oriented to the service and capable of supporting the construction of a new generation of M2M applications, common to the various activity sectors, ensuring a wide range of new businesses and leveraging the current efforts of standardization.

The structure of the article is divided as follows: chapter 2 presents the current state of art, highlighting the normative tendencies; in chapter 3 the suggested architecture is presented, emphasizing the importance of the creation structures and service delivery in M2M environments; finally, chapter 4 summarizes the main conclusions and presents the future work.

## 2. State of art in M2M architecture

### 2.1 Standards

M2M communications have been specified by the standardization bodies, and the work done by 3GPP [1] and ETSI [2] (see References) stands out. It is also important to highlight the normative tendency presented by oneM2M that aims to standardize the contributions of the service layer of the various normative organisations [3] (see References).

### 2.2 3GPP

As far as 3GPP standardization activities are concerned, we have been watching the development of new technical specifications, as well as the improvement and increase of existing specification mechanisms. Based on the strategy of making the most of the infrastructure and access networks defined under the operator scope, 3GPP doesn't take the creation of a new architecture into consideration, but it joins and develops M2M abilities on the existing systems of invoicing, addressing, types of communication, connectivity of low mobility and fixed location terminals [4]. On the other hand, new conditions and changes in the existing standards are specified, allowing the operation of large numbers of subscribers and their corresponding data, in the network, the widespread use of M2M services, as well as the impact of security optimisations resulting from these mechanisms' addition.

The additional effort in the development of 3GPP systems supporting MTC communications (Machine Type Communications) has been highlighting mainly the optimisation of network resources [4] and the use of device identifiers, as an alternative to the common telephone numbers [5] (see References).

In this regard, as one can see in Figure 1, 3GPP is focusing its impact on the considerations related to supplying network access through terminals connected to data transport services or signaling messages.



**Figure 1: General M2M Architecture of 3GPP**

In this MTC context [6] (see References), the MTCu provides the device access to a 3GPP network, using the MTCi interface, which is the point of reference that allows an MTC server to connect to the 3GPP network, by using the corresponding connection services. Simultaneously, a point of reference is also made available, MTCsms, enabling this connection to be achieved using the SMS service.

So, the 3GPP specification frames mainly the development of an interoperable solution with the existing cellular architecture, but enabling the innovation of products and the expansion to new markets and reducing the associated cost through the additional evolution of existing standards when satisfying the essential regulations.

## 2.3 ETSI

The functional architecture for M2M communications has recently been specified [7] (see References). As shown in Figure 2, M2M architecture includes two domains: the Network Domain and the Device and Gateway Domain.

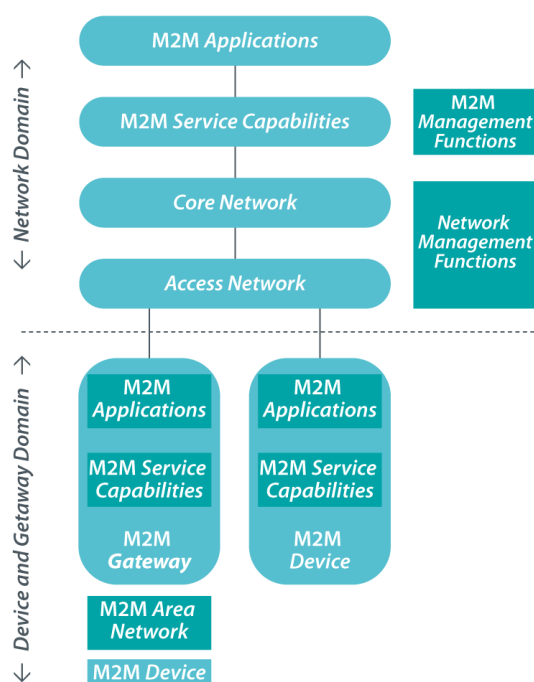


Figure 2: General M2M architecture of the ETSI

The Network Domain, as defined in the standard, includes several entities, in particular the following elements: M2M Applications, M2M Service Capabilities, Core e Access Network.

The Core Network and the Access Network enable applications to access information and actuators. The Core part makes IP connectivity available, guaranteeing also connection to other networks. The Access Network includes networks such as xDSL, GERAN, UTRAN, eUTRAN, W-LAN or WiMAX, and enables the communication between the Device and Gateway Domain entities and the Core Network ones.

The M2M Service Capabilities element makes a wide range of interest functions available for multiple applications shown through well defined interfaces. M2M Applications are applications that follow the service logic creating advantages for users or machines.

In the Network Domain there are two more functional entities: the Network Management Functions entity, which performs all the management tasks, related to communication networks, and the M2M Management Functions entity, which includes all the required features to manage M2M Applications and M2M Service Capabilities.

The M2M device domain, M2M Device and Gateway Domain, consists of three entities. The first one is called M2M Device is no more than a device that runs M2M applications using the features made available by M2M Service Capabilities of the network domain. The second entity, M2M Gateways, are equipments that, not only may run M2M applications, but also use M2M Service Capabilities to enable

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the interconnection of M2M Devices and ensure the connection to the Network Domain. They may also include logic so as to activate free-standing processes of collecting and handling a whole range of information, such as the one created by the sensors. Finally, the M2M Area Network grants the connection between the various M2M Devices and M2M Gateways. Technologies like Zigbee or Bluetooth are well-known examples of M2M Area Network.

## 2.4 OneM2M

The M2M market is considered to be quite desirable everywhere. So, the normative fragmentation the M2M has been put through is not strange. In order to avoid the creation and consolidation of competitor standards, the various standardisation bodies have joined their efforts to create a single standard for M2M. This was how, in the end of July, the oneM2M [3] (see References) initiative was born. The oneM2M initiative will focus its standard efforts on the service layer, targeting the consolidation of the different existing approaches.

It also aims at the cooperation with other standardisation bodies that intercept the M2M area (Figure 3). The oneM2M initiative will thus help to boost the industry in every activity field, granting a reduction in investment and operating and promoting a fast entrance of the services in this new market.

## 2.5 Scientific community

The scientific community is currently analysing questions of agnostic access to data generated by M2M devices, solutions for mechanisms of identification, addressing and forwarding, service, security and intercommunication quality levels through the various technologies of access networks.

In this context there are two large groups of solutions, considering incremental and disruptive architectures.

In the first case, the new mechanisms developed under the M2M scope are considered from the evolution of architectures and existing procedures, aiming at the reuse of existing technologies and adapting them to the new scenarios brought by M2M. So, in addition to presenting the requirements and features provided by this type of solutions [8][9], there is clear concern about its integration with existing infrastructures, whereas for instance the architectures of monitoring [10], service composition [11] and commitment of radio resources in LTE networks [12] (see References). This additional principle has though the disadvantage of offering resistance to the introduction of deep architectural reworking, which would involve the existing systemic restructuring, requiring the adoption of questions involving problems resulting from architectural inadequacy in the light of these new scenarios.



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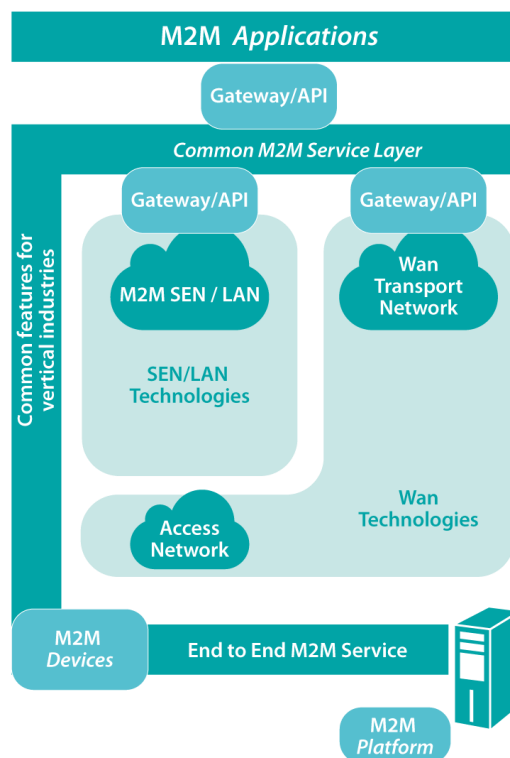


Figure 3: General M2M architecture of the oneM2M

In the second case the close relationship with existing architectures is broken (regarding services as well as communication infrastructure), enabling the adoption of new mechanisms and architectural concepts. In this context, there are the Future Internet oriented solutions, where challenges related to Internet future use requirements transcend the foundations of current Internet and establish the bases for the definition of new mechanisms and solutions. In this way, these solutions may offer new considerations that approach, in a holistic way, the problems of current Internet, maximising the functioning and framing of new technologies, like M2M. Examples of these systems provide the idealisation of more efficient communication mechanisms [13], architectures of mobility in wireless heterogeneous networks [14], and energy science [15] and the massive access to devices forming an Internet of Things [16] (see References). However, in this type of disruptive solutions, some misalignments with existing technologies are common, leading to the frequent adoption of new architectures and processes, making them less appealing from business perspective.

It should be noted however that these solutions offer a new vision over future potential, as well as providing answers to many problems regarding the initial Internet architecture.

## 3. Service-oriented architecture

### 3.1 SOA concepts

A service oriented architecture (SOA) intends to meet the growing needs of heterogeneous systems, possibly distributed, though guaranteeing its scalability and flexibility. A SOA approach does not stipulate a specific architecture, but it leads to the definition of a particular architecture.

A service oriented architecture enables the focus on business, abstracting it through service creation. So, a SOA system intends to structure large distributed systems enabling the abstraction of rules and features of business in a technology-agnostic way.

One of SOA pillars is the guarantee of a high interoperability level, allowing the connection of different services in a highly heterogeneous environment. On the other hand, SOA environments need to grant the weak coupling of the various services in order to strictly alleviate possible dependencies.

### 3.2 SDF

Telecommunications operators have been adopting new paradigms of service delivery, based on SOA, in order to respond to the challenges and threats raised by the Over-The-Top, such as Google, Skype or Facebook. The Service Delivery Framework (SDF) represents the application of SOA concepts to the world of telecommunications, expediting the whole management of service life cycle and making the creation of new businesses easier. SDF makes a service execution environment available, as well as data repositories and a whole range of standardised enablers accessible to any application.

In technical terms, there is a whole range of abilities provided by the various service enablers that are consumed through API published in the service bus. The service bus, in turn, works as a mediator in all interactions between suppliers and customers, guaranteeing a high level of interoperability, but simultaneously ensuring the low dependence among services. The service enablers encapsulate different types of resources, such as network resources (e.g. IMS, SMSC), operation and business support resources (e.g. Online Charging Systems) and resources outside the operator scope, such as third parties gateways (e.g. Facebook Connect). SDF incorporates its own management tools called Service Delivery Support Services (SDSS), which are used in order to guarantee consistent management of the service life cycle, including conception, design, implementation, functioning and removal.

### 3.3 NGM2M architecture

Telecommunications operators need to develop their telecommunication systems in order to grant a preponderant role in this new world of connected objects. The massification of M2M communications will leverage the emergence of new markets that need a high level of management flexibility in the new services, which will be transversal to the various areas of business.

The suggested next generation M2M architecture (NGM2M) can be seen in Figure 4.

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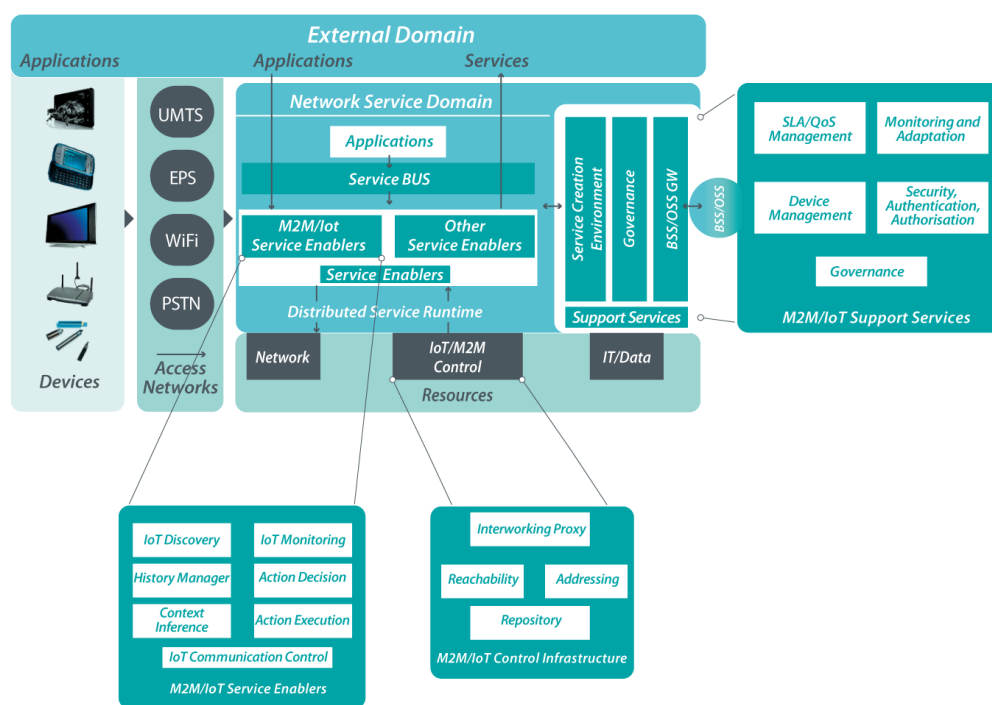


Figure 4: NGM2M Architecture

## 3.4 Service Creation Environment

In SDF architecture, the Service Creation Environment (SCE) is the component that provides a whole range of features that enable the fast creation of services, generating thus new businesses. This characteristic is particularly relevant in an M2M ecosystem due to the great market dynamics and to the expected interaction of the multiplicity of sensors, actuators and new services.

The SCE in NGM2M architecture foresees the use of flow control languages, such as BPEL or BPMN2, or through the creation of rules (e.g. Drools). These technologies are a fundamental support to service creation because, either by the languages inherent simplicity used in rule creation, or by the possibility of using flow graphs editors, they ensure the simplicity in designing a new product. So, a business specialist does not need to have deep technical knowledge to create new applications and develop new businesses.

## 3.5 Service performance

The M2M service performance involves the existence of a new range of devices, where a broad array of sensors and actuators meet. This wide range of new machines with communication ability will lead to the enrichment of the applications offer in service-oriented architectures.

The suggested architecture also involves the existence of a range of new enablers capable of ensuring the effective access to sensory information and to the implementation of actions supported by the actuators. The IoT Discovery enabler exposes M2M services to the interested entities, bridging suppliers and consumers. This enabler also provides a full description of the associated interfaces, as well as the features exposed by the services. The existence of an enabler is also necessary to ensure the preservation of information considered relevant. So, in this architecture one suggests the History

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Manager, which uses specific policies to control the data archive. This element interacts with the elements involved in communication in order to have access to information. One of the critical issues of M2M communications is the amount of exchanged information. So, here one suggests the IoT Monitoring enabler that will supervise the competition of certain events regarding resources, avoiding the congestion of the bus through data exchanged among applications. To be valuable, information needs to be meaningful. In this architecture one suggests the Context Inference enabler whose main mission is to analyse and give meaning to the basic information captured by the sensors, inferring the highest level contextual information, making it available to interested entities. It's important to highlight that this element supports different mechanisms of reasoning in order to include a comprehensive set of informative needs. The Action Decision enabler's main task is to perform in real time the processing of the information received from the various system entities, thus influencing the unfold of the service logic. These actions are afterwards implemented by the Action Execution element, which executes the required features. Finally the Communication Control element includes all the features related to the management of communication between devices and service platforms. So, this enabler controls the establishment, change and elimination of the transport channels. It also has the task of ensuring the encryption and the integrity of the information exchanged among the different elements. In addition, it grants the atomicity of made transactions, making it possible to reestablish the state in which it was before, in case of partial failure. This enabler is also used to select the communication interface every time the devices have more than one accessible technology. Finally, the Communication Control allows the request/response as well as publish/subscribe communication models.

The integration of machine-to-machine communications in SDF architecture also includes the existence of certain elements that perform the M2M resource control. So, one suggests the existence of the entity Interworking Proxy to guarantee the connection between devices and gateways that follow different standards or specifications and the service platforms of the operator, ensuring its interoperability. Given that there are typically heavy energy constraints in the gateways, but mostly in devices, the existence of the Reachability element is recommended. This entity grants the existence of notifications, not only to the operator platform, but also to interested services, including information concerning the condition of devices and gateways, being also able to stipulate the scheduling of its future activations. An important issue one puts is the addressing when dealing with sensors capable of communicating through the various interfaces. The Addressing entity intends to control the network addresses of the various devices and gateways thus guaranteeing its accessibility. Finally, it is necessary to guarantee that the exchanged information is not lost. For that the existence of the Repository element that stores in real time the information that flows on the net is essential. This information may afterwards be accessed by authorised consumers.

Finally, it is necessary to develop the Support Services in order to guarantee a reliable management of the IoT services life cycle. The functional element SLA/QoS Management is responsible for ensuring the meeting of achieved commitments by the communications operator with his customers concerning the delivery conditions of M2M services. The Monitoring and Adaptation entity is in charge of monitoring M2M services, allowing their adaptation to context changes. In the M2M universe, a task of great importance is the possibility of configuring all devices remotely. So, the functional element Device Management makes a range of utilities available that enables the remote management of sensors and actuators. In order to deal with issues related to M2M security, the functional element Security, Authentication and Authorisation is suggested. Here the procedures concerning the management of access rights to IoT resources are performed. Finally, the functional element Governance implies a consistent behaviour for all IoT services throughout their life cycle.

## 3.6 Scenario

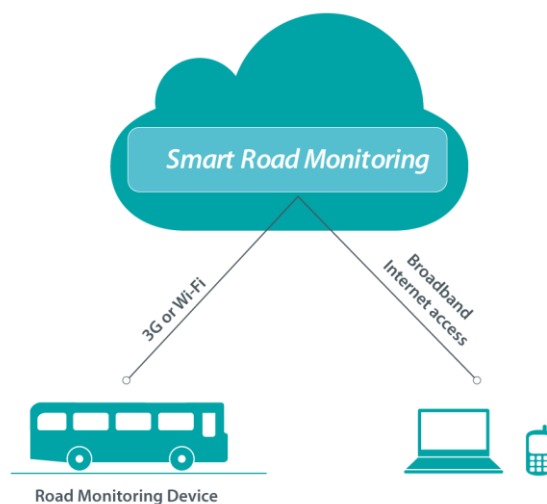
One of the areas where M2M communications may play a predominant role is the smart cities

domain. There is a growing search for management models of the cities that improve

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the effectiveness, cost-cutting, sustainability e quality of life for citizens. In this context, information and communication technologies play an increasingly important role, offering more efficient and interactive public services, adding to the increase in quality of the information provided to citizens and to a better and more enlightened decision- making related to infrastructures and resources management. Machine to machine communications and the “Internet of things” (IoT) make up a new reality that will bring cities and their citizens innumerable advantages, enabling the collection of information of devices connected to the various everyday objects (e.g.: cars, household appliances, bridges, etc.) and the supply of services that, based on the gathered information, act smartly or transform it into useful information for decision making. In this domain, there are many areas that can take advantage of the use of M2M and IoT, namely urban mobility, management and monitoring of infrastructures and resources, traffic automation, energetic efficiency of leisure parks, buildings and other infrastructures, the safety of people and goods, among others.

A possible implementation scenario refers to road condition monitoring, here called Smart Road Monitoring (Figure 5).



**Figure 5: Smart Road Monitoring**

Based on data gathered from devices installed in vehicles, with geolocation (GPS) and movement devices (accelerometer) and with storage, processing and communication capacity via mobile network or Wi-Fi, and through analysis and processing processes, services are made available to the entities that run road infrastructures of cities. The information to make available includes for instance maps with information about the road condition and indication of points of attention (holes, irregularities, etc.), top places with situations of severe road degradation, reports, indicators and alert and notifications generation.

The smart monitoring of road condition is an important support tool for the rigorous knowledge of road condition, for timely acting in severe degradation situations and for the establishment of repairing priorities. The timely action in hole repairing on roads also presents advantages regarding the service image perceived by users.

## 4. Conclusions

Telecommunications operators have the opportunity to promote new businesses with machine to machine communications. But to be successful, they will have to develop their telecommunications systems in order to support a new range of innovative businesses, which handle the various lines of business.

If they want to lead this new market, they will have to transform their systems in a way that they can ensure the creation of new services, supported by distributed systems, guaranteeing the connectivity of the various devices. Simultaneously, they cannot afford to neglect the compatibility with the specifications developed by standardisation bodies. This article intended to present an architecture capable of supporting new businesses, granting the creation and execution of new M2M services, supported by heterogeneous and highly flexible networks, capable of placing the operator as key player in an increasingly demanding and competitive market.

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